AC 2011-1829: EXCHANGE-ENGINEERING IS ELEMENTARY LESSONS THAT HIGHLIGHT SUSTAINABILITY

Sharlene Yang, Museum of Science, Boston

Sharlene Yang is the professional development director for the Engineering is Elementary project. She has ten plus years of experience as both a science educator and researcher that includes teaching biology, environmental outreach education, and research in biopsychology. Prior to joining the EiE team, Sharlene was a founding teacher at an alternative school for ”at risk” teens; she understands the challenges of working with children that struggle in a mainstream school environment and the importance of creating a classroom that fosters inquiry and student-centered learning. With that in mind, Sharlene conducts teacher professional development that not only teaches content, but models strong science pedagogy so that elementary school teachers can experience for themselves the power of inquiry-based and open-ended learning. Sharlene received her B.A. in Biology and Psychology from Cornell University, her M.S. in Biopsychology from the University of Michigan, and her M.A.T. in Science Education from Tufts University.

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Exchange—Engineering is Elementary Lessons that Highlight Sustainability

The Engineering is Elementary (EiE) project has created 20 elementary-level engineering units that integrate with science topics. This session will provide an overview of the EiE materials with a particular emphasis on the lessons that highlight sustainability and green engineering. These include:

1. **Catching the Wind: Designing Windmills (Mechanical Engineering)**
   This unit guides students to think like mechanical engineers as they use their knowledge of wind to design and create machines that can be used to capture wind energy. The storybook "Leif Catches the Wind" reinforces the science concept of air as wind, and introduces the field of mechanical engineering. The wind turbines found in Leif's home country, Denmark, are used as an example of a renewable energy source and a machine designed in part by mechanical engineers.

   Students will look critically at several common machines (mechanical pencils, egg beaters, rolling pins) and diagram how the parts of the machine interact with other parts of the machine and allow the object to function. Students will then use their mechanical engineering skills to explore different materials and shapes conducive to catching the wind, first by designing sails for small boats and finally for designing windmill blades.

2. **Thinking Inside the Box: Designing a Plant Package (Packaging Engineering)**
   In this unit, students encounter the rapidly growing field of package engineering. They take a fresh look at the packaging they encounter daily--and often toss out without appreciating its importance. As children investigate the functions of packages, they discover the relationship between the needs of the product (in this unit, a plant) and the functions that must be considered in package design, and consider the factor of source reduction in their design's improvement.

   Ultimately, students design, test, and improve their own packages to solve a tricky challenge: carry a plant and keep it safe for several days--while also ensuring it has the light, air, and moisture it needs.

3. **Water, Water Everywhere: Designing Water Filters (Environmental Engineering)**
   This unit addresses the increasingly important issue of water quality through lessons that teach students about water contamination and the ways that people ensure the quality of their drinking water.

   Students will first think like environmental engineers as they review a mural of a small American community, noting possible sources of pollution and suggesting ways to clean up or eliminate the source of the pollution. Students will then focus on the environmental engineering problem of providing safe drinking water as they plan, construct, test, and improve their own water filters.

4. **Now You're Cooking: Designing Solar Oven (Green Engineering)**
   This unit guides students to explore energy, and how heat energy from the Sun can be harnessed by a solar cooker to heat food. Many students might take technologies such as stoves, ovens, and toasters for granted, but these conveniences aren't available to Lerato, a girl who lives in Botswana. Through the storybook Lerato Cooks Up a Plan, students will be introduced to Lerato and her family. Lerato and her siblings have to gather firewood in order to build a cooking fire to heat their food. When Tsoane, another villager, returns from University, Lerato learns about the field of green engineering. Green engineers are concerned with designing technologies that have as little impact on the environment as possible. Tsoane shows Lerato how she could use a well-insulated solar cooker to help

cook food, eliminating the chore of gathering firewood and the environmental impacts of creating cooking fires. Key concepts introduced in the storybook include life cycle assessments of engineered products, thermal insulators, and thermal conductors.

In the classroom, students are given the challenge of creating a well-insulated solar oven. Students will test an array of materials to find the best thermal insulators, and will also consider the environmental impacts of each material. Once students have tested and analyzed each material, they will design and test their own solar cookers.

5. **A Slick Solution: Cleaning an Oil Spill (Environmental Engineering)**
   In this unit, students are introduced to a girl named Tehya who is a member of the Lower Elwha Klallam tribe. While walking by the Elwha River near her home in Washington state, Tehya and her friend Sam are horrified to find an oil spill. With the help of Thomas, a neighbor and environmental engineer, Tehya and Sam play an active role in the clean up efforts. Students learn about the interconnectedness of components of an ecosystem, methods for cleaning oil spills, and the severe impact oil spills can have on an ecosystem.

   Throughout this unit, students will act as environmental engineers using their knowledge of ecosystems, environments, and properties of materials to design solutions to environmental problems. Students will investigate the pH of soil and water samples to gather clues to identify potential sources of pollution in a fictional town. This exercise points out that pollution is rarely an isolated problem—pollution in one area often spreads through soil, water, and air to other areas. They will have the opportunity to test and think carefully about properties of various materials that might be used to help clean an oil spill. Finally, students will be able to design, test, and improve their own process for cleaning an oil spill.

Copies of these units will be available. The unit binder includes 4 lessons: (1) an engineering story, (b) a broader view of an engineering field, (c) scientific data inform engineering design, and (d) engineering design challenge. In addition to teacher lesson plans, the binders include student worksheets, assessment materials, and background resources.